This rate was over three times the base rate. A criminal environment enhances the predisposition.

Fini Schulsinger's previously published adoption study of psychopathy is reprinted in this volume. Starting with a group of adopted psychopaths and a group of adopted controls Schulsinger found psychopathy five times as prevalent among the biological parents of the psychopaths as among their adoptive parents. There was little or no psychopathy among the biological and adoptive parents of the controls. All the researchers writing in this volume are cautious in drawing inferences about the relative influence of environment and heredity in criminality. Given the great heterogeneity in crime and criminals they seem wise to accept that environmental factors play a major role in many types of crime. Mednick interprets the evidence to indicate that variations in the environment best account for crime among the lower class whereas genetic factors are linked to crime among the middle and upper classes.

The epidemiological facts provided by the many large-scale Scandinavian studies also provide an interesting new perspective on crime. By comparison with the situation in the United States, poverty and other adverse environmental circumstances have been drastically curtailed in Scandinavia, yet about 9 percent of males receive felony convictions during their lifetimes. Does this fact represent a limit to what socialism can accomplish in crime reduction? Perhaps not, but it might encourage a search for environmental variables qualitatively different in character from social class, health, and employment.

Another fact emerging from a number of the investigations reported here is the association between criminal behavior and schizophrenia. Kirkegaard-Sørensen and Mednick report that rates of criminality are significantly elevated among the offspring of schizophrenic mothers. Similar results are obtained in adoption studies where the schizophrenic mothers had nothing to do with rearing their children. Perhaps the contribution of the schizophrenic mother was genetic.

Overall, this book leaves the reader with the impression that evidence from various sources is slowly converging on the idea that individual differences among criminals are real and that even eradication of environmental inequities will not make them all go away. Some criminals, perhaps the very worst, are very different from the rest of us. These differences seem most pronounced in that small group of active recidivists that commits up to half of all crimes. We cannot afford to neglect the possibility that biological factors are significantly linked to crime in this group.

JOSEPH M. HORN
Department of Psychology,
University of Texas,
Austin 78712

A Study in Human Capacities

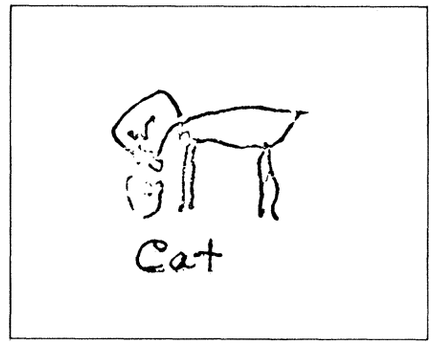
Genie. A Psycholinguistic Study of a Modern-Day "Wild Child." SUSAN CURTISS. Academic Press, New York, 1977. xvi, 288 pp. $27.50. Perspectives in Neurolinguistics and Psycholinguistics.

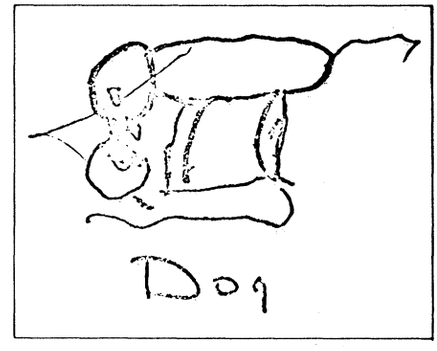
In his book *Biological Foundations of Language* (Wiley, 1967) E. H. Lenneberg hypothesized that language learning in humans is constrained to a particular developmental period; if a human is to acquire language, he or she must do so roughly between the age of two and puberty. According to Lenneberg, behavioral evidence for the lower bound of this critical period comes from normal language acquisition, which does not universally begin until about age two. Evidence for the upper bound comes primarily from pathology. Damage to the left side of the brain (the hemisphere dominant for language in most people) before the age of 13 usually will not result in permanent language impairment; damage after that age tends to produce irreversible language losses. Moreover, language acquisition in retardates proceeds at a slow but steady pace until age 13, at which time linguistic progress, regardless of level attained, halts.

The crucial test of the critical-period hypothesis is, of course, whether an individual prevented from learning language during the first 13 years of life can develop language thereafter. For obvious reasons the experimental manipulation that would answer this question has not been carried out. However, tragic circumstances have created Genie, the subject of this book and a test case for the critical-period hypothesis.

Genie was discovered at the age of 13 years, 7 months, after having experienced a childhood of extreme and unusual deprivation and abuse. From the age of 20 months, she had been confined to a small room and allowed no freedom of movement, no perceptual stimulation, and no human companionship. Under these inhumane conditions, it is hardly surprising that Genie did not develop language.

Since the time of her discovery in 1970, attempts have been made to rehabilitate and educate Genie. This book is a description of Genie's first five years after discovery, focusing on her linguistic progress. Four chapters describing Genie's language abilities make up the bulk of the book. One deals with Genie's phonology, both comprehension and production. Two others focus, respectively, on her comprehension and on her production of syntax, morphology, and semantics. The fourth of this group of chapters compares Genie's linguistic ca-





"Genie's drawing of a human figure (12/22/71). Note the lack of either trunk (if lines represent arms) or arms (if lines represent trunk), and legs, ears, hair, clothes, and so forth. Contrast this primitive figure with the detail she produced when asked, at an earlier time (11/8/71), to draw 'a cat eating,' 'a dog eating.' The animals have a well defined trunk and head, four legs, and other features. The tongue, one eye, and tail are in keeping with a profile view, a fairly sophisticated perspective." [From *Genie: A Psycholinguistic Study of a Modern-Day "Wild Child"*]

pacities with those of normal children. Most of the linguistic data presented in the book come from comprehension tests developed by the author solely for the purpose of tapping Genie's linguistic skills and from observations made by the author of Genie's speech (detailed notes, videotapes, and audiotapes).

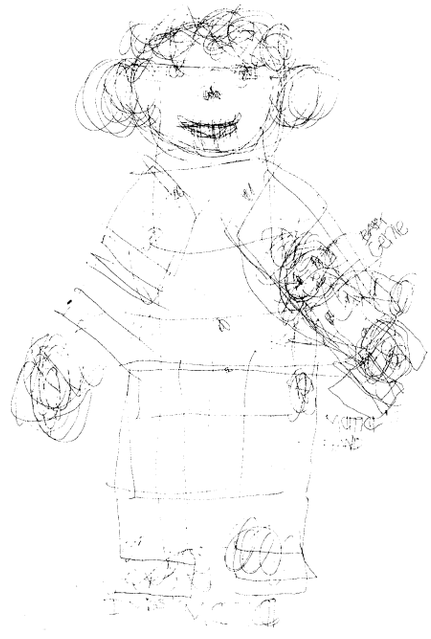
In general, the comprehension and production data in the book, although presented in a somewhat scattered and redundant fashion, will be of much value to researchers in the various fields of language study. Since Genie spoke rarely even several years after her discovery, an appendix listing all of her utterances would probably have been manageable and would have made the book even more useful as a data source.

Genie's language skills were minimal at the outset. She was able to comprehend a small number of single words, but showed no comprehension of syntax and never spoke. Over the course of the five years reported on here, Genie made considerable progress in both comprehension and production. She began producing spontaneous sentences and gave clear evidence of complex comprehension. Her language exhibited syntactic rules; for example, the sentences she produced followed word-order rules such as "possessors precede possessed nouns" (for example, "Jones shampoo," "Curtiss car"). Genie's language also had the important property of recursion—that is, the recombination of elements in different ways—both in production (she produced verb + complement sentences such as "Talk Mama to buy Mixmaster" [I'll tell Mama to buy me a Mixmaster]) and in comprehension (she correctly understood sentences like "The girl who is sitting is looking at the boy"). Thus, Genie's progress suggests that language acquisition can indeed occur beyond the critical period.

It must be noted, however, that Genie's language at the time of writing was far from normal. For example, it had no proforms ("what," "which," "this," and the like), had no movement rules (Genie produced no passive sentences, such as "John was hit by a ball," and no sentences with subject-auxiliary inversion, such as "Are you sleeping?"), and had no auxiliary structure (for example Genie consistently omitted "have" and "will" in sentences such as "John will have gone home").

Taken together these findings suggest that the original critical-period hypothesis should be rephrased. The question is no longer whether or not language must be learned during a critical period, but rather which aspects of language must be learned during the critical period and which can be acquired beyond it. The data described in *Genie* offer a tentative answer to this revised question (tentative because Genie's language may continue to improve and because Genie's general development prior to age 13 was far from normal). It now appears that some properties, such as ordering rules and recursion, can be developed beyond puberty and other properties, such as proforms, movement rules, and auxiliary structures, cannot.

Curtiss attempts to interpret these data in a broader context by considering Genie's accomplishments as one among several examples of language learning by a "nonlanguage" cortex. To this end, she compares Genie's language with the languages of three other types of language learners: young children during the first stage of language acquisition (Brown's stage I), who are assumed by Curtiss to be learning language before their "language" cortexes are maturationally equipped to do so; chimpanzees learning American Sign Language, clearly a case of language learning with a nonhuman cortex; and left-hemispherectomized adults who must reacquire language with their right, "nonlanguage" hemispheres. Curtiss claims that these three populations all have the same "gaps" in their languages as are found in Genie's—that is, they lack proforms, auxiliaries, and movement rules. She then generalizes from this that these three properties of language are among those that cannot be learned by the "nonlanguage" cortex.



"For the first few years after her emergence from isolation, Genie drew only upon request. In the last few years, however, Genie has turned to drawing as a way of dealing with and expressing her thoughts, feelings, and fantasies." In 1977, Genie drew the picture shown here. "At first she drew only the picture of her mother and then labeled it 'I miss Mama.' She then suddenly began to draw more. The moment she finished she took my hand, placed it next to what she had just drawn, motioning me to write, and said 'Baby Genie.' Then she pointed under her drawing and said, 'Mama hand.' I dictated all the letters. Satisfied, she sat back and stared at the picture. There she was, a baby in her mother's arms. She had created her own reality." [From *Genie: A Psycholinguistic Study of a Modern-Day "Wild Child"*]

One might immediately object to this line of argument on the grounds that there is no reason to believe that young children begin to learn language with "nonlanguage" cortexes, nor is there reason to believe that a chimp's cortex is comparable to a human's "nonlanguage" cortex. Moreover, its lacks notwithstanding, Genie's language as it develops is much richer than anything yet attributed either to a chimp (in having recursion and word-order rules) or to a stage I child (in having recursion). Thus comparison of the troughs of Genie's uneven product either with the chimp's primitive product or with the stage I child's immature product seems strained. Furthermore, to attribute the shared lacks to a common source seems at the very least to overstep the data.

Of the three comparisons, only the one with the left-hemispherectomized patients potentially learning language after puberty appears well drawn. Curtiss shows that the similarities between Genie's language and right-hemisphere speech go beyond "gaps." Adults depending on their right hemispheres have been reported to have good vocabulary abilities, better semantic than syntactic abilities, better comprehension than speech, and difficulties with word-order comprehension, all attributes Genie exhibited as well. These similarities suggest to Curtiss that Genie might be learning language primarily with her right and not her left hemisphere. The final section of the book details Genie's neurolinguistic abilities and attempts to confirm this hypothesis. Dichotic listening tests (used to ascertain hemispheric dominance) are described whose results suggest that Genie processes words almost exclusively with her right hemisphere.

Additional dichotic listening tests with environmental sounds suggest that Genie relies on her right hemisphere to process nonverbal stimuli as well. Moreover, Genie performed extraordinarily well on tests of cognitive abilities usually considered to tap right-hemisphere skills (for example, tests of gestalt perception, part-whole judgments). In fact, on cer-

tain of these tests, Genie's performance was the highest reported in the literature for either child or adult.

Along the same lines, Genie's performance on tests involving left-hemisphere abilities was below normal (for example, on several tests of sequential order). More problematic, however, was her poor performance on certain tests that have been assumed to tap right-hemisphere skills (for example, facial recognition, memory for designs). The author's explanation of these anomalies is that these particular tasks tap both right- and left-hemisphere abilities and therefore should be difficult for Genie. The argument begins to take on a rather ad hoc quality here. However, in light of Genie's remarkably good performance on certain tasks and poor performance on others, her pattern of abilities might itself be used to generate hypotheses about right as compared to left brain skills.

The data can be interpreted in a still broader context by considering the possibility (not explicitly taken up by Curtiss) that human language acquisition may be constrained not only by the time of acquisition but also by the nature of experience during that time. The literature on the role of linguistic input in language acquisition suggests that certain aspects of language may be sensitive to a finely tuned linguistic environment while others may not. For example, deaf children who have not yet learned oral language and who have not been exposed to a conventional sign language can develop a spontaneous gesture system that has languagelike properties such as ordering rules and recursion (S. Goldin-Meadow and H. Feldman, *Science* **197**, 401 [1977]; H. Feldman, S. Goldin-Meadow, L. Gleitman, in *Action, Gesture and Symbol*, A. Lock, Ed., Academic Press, in press). These properties, developed without a conventional language model, are also found in Genie's post-pubertal language. These same deaf children do not develop language properties, such as auxiliary structure, that so far are missing from Genie's language as well. Furthermore, in studies of normal hearing children, the auxiliary is one of the few language properties whose rate of acquisition has been shown to be sensitive to variations in the child's linguistic input (E. L. Newport, H. Gleitman, L. Gleitman, in *Talking to Children*, C. A. Ferguson and C. E. Snow, Eds., Cambridge University Press, 1977). The experience with Genie thus provides further evidence concerning constraints on language development. Some properties of language, such as the auxiliary, may be "fragile," more likely to be developed during the critical period and more likely to be developed with a finely tuned linguistic environment. Other properties, such as ordering rules and recursion, are apparently more "resilient" and can be developed beyond the critical period and with no exposure to a conventional linguistic model.

Several points that highlight the relationship between thought and language are made in the book. When Genie began acquiring speech, she learned many more color words and adjectives expressing size and quality (such as "funny" and "silly") than does a normal child at the earliest stages of language acquisition. Genie's initial two-word phrases reflected this interest in attributes and primarily involved modifications of nouns ("two hand," "lot bread," "fat grandma," "yellow balloon"), as did many of her longer utterances ("small two cup," "little white clear box"). Thus the content of Genie's utterances, while roughly comparable to that of the normal child's, did appear to reflect biases she brought to the language-learning situation (evidently she had a tendency to focus on the physical attributes of the world around her). Moreover, even though Genie was a beginning language-learner, she did not overgeneralize words (that is, use one word such as "bow-wow" to refer to various objects—dog, cow, cat, and so on) as does a normal child. This suggests that certain aspects of normal two-year-old language may reflect properties of the two-year-old mind and not properties of early language learning in general.

Genie's speech also contains references to events that occurred before she possessed language. For example, she described the fact that her father had beaten her during her years of confinement, "Father hit arm. Big wood. Genie cry." As her language improved, she conveyed the same sad tale in single, longer sentences: "Father hit Genie big stick," "Father make me cry." This is a striking example of a human's ability to encode and recall events experienced before the acquisition of language.

The book is sensitively written and manages to convey a sense of Genie both as an individual and as a language user. Genie's story is (we may be thankful) a unique one, from which we can hope to learn much about the resilience of human language-learning capacities. As long as Genie continues to progress, the story is not ended.

SUSAN GOLDIN-MEADOW
Department of Education, University of Chicago, Chicago, Illinois 60637

Asymmetry and the Brain

Lateralization in the Nervous System. STEVEN HARNAD, ROBERT W. DOTY, LEONIDE GOLDSTEIN, JULIAN JAYNES, and GEORGE KRAUTHAMER, Eds. Academic Press, New York, 1977. 1, 538 pp., illus. $21.50.

Evolution and Lateralization of the Brain. Papers from a conference, New York, Oct. 1976. STUART J. DIMOND and DAVID A. BLIZARD, Eds. New York Academy of Sciences, New York, 1977. vi, 502 pp., illus. Paper, $40. Annals of the New York Academy of Sciences, vol. 299.

In vertebrates and other bilateria the sensory-central-motor loops that control behavior are bilaterally organized. In contrast, the viscera and their neural control systems depart, often grossly, from bisymmetry. So we look to the behavioral rather than the vegetative needs of the organism for the adaptive rationale for bisymmetry. That the adaptation involved is primarily movement becomes apparent when we consider that it is in motile forms that bisymmetry is most strictly observed, in sessile forms that it is most freely violated. The bisymmetrical organism is rostrocaudally polarized, with distance receptors, organs of prehension, and the major concentration of neurons rostrally located. Because at any instant the organism surveys only a limited section of ambient space, its survival depends on its ability to deploy its sensory-motor equipment in any direction by rapid orientation. By its ability to turn quickly in any direction, the organism becomes functionally circular and prepared for the spatially random incidence of potentially relevant events. Moreover, although unilateral turning would suffice to cover all 360 degrees of arc, a less cumbersome arrangement in fact occurs: an approximately equal balance of opposing right and left turning tendencies, represented at various levels of central nervous organization. Where departures from bisymmetry occur, their